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Description of the Guidelines of Peripheral Intravenous Antimicrobial Medication Administration

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The purpose of this final project was to describe the guidelines for peripheral intravenous administration of antimicrobial medication. A review of literature published between January 2004 and December 2014 in electronic databases (PubMed, Medline, CINAHL and Cochrane) was carried out and the principles of an inductive content analysis were applied in analyzing 12 articles that were chosen for review.

In this literature review no comprehensive guidelines relevant to nursing practice in the administration of intravenous antimicrobial medication were identified. Only scarce and fragmented guidelines, recommendations and instructions regarding the dosage, preparation and storage of intravenous solutions as well as the duration and timing of infusion of antimicrobial medication were found.

The authors found that there is an abundant variety of high quality, evidence based medical guidelines. The scarcity and poor quality of nursing guidelines was evident. This finding emphasizes the crucial need for clinical nursing perspective in future guideline development.

Keywords	Nursing, Antimicrobial, Guidelines, Peripheral intravenous administration

Tekijä(t) Otsikko Sivumäärä Aika	Marilyn Bomett, Niko Salonen Kuvaus perifeerisen laskimonsisäisen mikrobilääkityksen annon ohjeista 18 sivua + 3 liitettä 20.4.2015
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Tämän opinnäytetyön tarkoitus oli kuvata perifeerisen laskimonsisäisen mikrobilääkityksen annon ohjeita. Suoritimme katsauksen tammikuun 2004 ja joulukuun 2014 välillä elektronisissa tietokannoissa (PubMed, Medline, CINAHL, Cochrane) julkaistuun kirjallisuuteen ja sovelsimme induktiivisen sisällönanalyysin periaatteita 12:n katsaukseen valitun artikkelin analyysissa. Tässä kirjallisuuskatsauksessa ei löydetty yhtäkään kokonaisvaltaista hoitotyölle olennaista laskimonsisäisen mikrobilääkityksen annon ohjetta. Löysimme ainoastaan vähäisiä ja hajanaisia ohjeita, suosituksia ja ohjeistuksia liittyen sekä laskimonsisäisten liuosten annosteluun, valmistamiseen ja säilytykseen että mikrobilääkkeen annon kestoon ja ajoitukseen.

Siinä missä korkealaatuisia, näyttöön perustuvia lääketieteellisiä ohjeita löytyi runsaasti, hoitotyön ohjeiden niukkuus ja heikko laatu oli ilmeistä. Tämä tutkimustulos korostaa korvaamatonta tarvetta kliinisen hoitotyön näkökulmalle tulevaisuuden ohjeiden laatimisessa.

Avainsanat	hoitotyö, mikrobilääkitys, ohjeet, perifeerinen laskimonsisäinen

Contents

1 Introduction

Throughout the past decades a remarkable increase in guideline development has occurred due to professional, public and political request for evidence-based practice (Craig & Smyth 2007: 237). Past guidelines were based on tradition, individual opinion or contemporary practice, but currently guidelines are expected to be founded on evidence. While a substantial collection of evaluated clinical guidelines has been developed in medicine, there is a growing interest and demand for evidence based clinical guidelines in nursing. (Craig & Smyth 2007: 238.)

In this final project the term guideline will be used to refer to literature titled best practices, guidelines, policy, protocol, recommendations, standard of practice or instructions.

Antimicrobial medications are used to manage infections caused by different microbes. Bacteria, fungi, protozoa and viruses are examples of microbes, which are organisms of microscopic or submicroscopic size, invisible to the naked eye. Antimicrobial drugs are called by different terms, each with slightly different meaning. Pharmacological classification groups the antimicrobial agents according to their action mechanism. For example bacteriocidal agents kill bacteria, while bacteriostatic drugs manage to slow or inhibit the growth of bacteria. (Adams & Urban 2013: 829; Medical Dictionary for the Health Professions and Nursing 2012.)

Elimination or control of an invading micro-organism while not damaging healthy body cells is the foundation of effective antimicrobial therapy. Early forms of antimicrobial therapy involved the use of chemicals such as mercury or carbolic acid that had shown to kill bacteria. However, these as well as other bacteriocidal chemicals would often cause equal amounts of damage in the patient's healthy body cells as they did to the microbe causing infection. Contemporary antimicrobial medications selectively target features present on invading microbes but not on human cells, thus reducing harm to the patient. (Wilson 2006: 87.)

Antibacterial, antiviral, antiretroviral, antifungal, antiparasitic, antihelminthic and antiprotozoal medications are all anti-infective drugs that fight microbial infection

(Aschenbrenner & Vennable 2009: 746). For clarity purposes the term antimicrobial medication will be used in this final project to refer to any kind of anti-infective drug.

There is a worldwide concern over the increasing emergence of antimicrobial resistance (Barajas, López-Alcalde, Roqué i Figuls, Solá, & Bonfill Cosp 2013: 5). The rapid development of drug-resistant strains of micro-organisms is enabled by their fast cell division, which includes mutations that can lead to developing an advantage against anti-microbial agents that previously have been effective against the micro-organism. The development of resistant strains has been shown to be promoted by widespread utilization of antimicrobials, but can be hindered by means of infection prevention and control, accurate diagnosis and therapy as well as rational use of antimicrobials. (Adams & Urban 2013: 831-833.)

Resistant strains of micro-organisms can develop due to inappropriate use of antimicrobials (Sanchez-Manuel, Lozano-Garciá, & Seco-Gil 2012: 2). It is crucial for nurses to have a comprehensive understanding and knowledge of appropriate antimicrobial medication administration, infection control policies and antimicrobial resistance patterns. This will aid in prevention and controlling of further antimicrobial resistance. This will help maintain the usefulness of currently used antimicrobial medications. (Guervil & Chau, 2013: 345.)

This final project focuses on antimicrobial medication administration through peripheral intravenous access. Intravenous administration is irreversible and with a variety of risks such as local irritation, phlebitis, infiltration, extravasation, infection, fluid overload, embolism, thrombosis, anaphylaxis and even death (Aschenbrenner & Vennable 2009: 34; Scales 2008: 4; Intravenous Nursing New Zealand Incorporated Society 2012: 56-62).

2 Background

2.1 Nursing guidelines

The term clinical guideline can be defined as a “systematically developed statement to assist practitioner decisions about appropriate health care for specific circumstances”

(Field & Lohr 1990 cited in Craig & Smyth 2007: 238). They are used to practice evidence based nursing and for reduction of incorrect practice (Craig & Smyth 2007: 238). The aim of evidence-based practice is the development of efficient interventions to achieve the best possible quality and quantity of patients' life (Craig & Smyth 2007: 269).

Guidelines ought to comply with approved standards and include documentation of adherence to the standards. Nursing has been involved in multiprofessional teams developing clinical guidelines.The quality of clinical guidelines in nursing requires improvement, because instead of research evidence they are widely based on professional opinion. Comprehensive systematic review provides a foundation for the development of useful guidelines that will integrate research into nursing practice. (Newhouse 2010: 57-59.)

Support and criticism of the use of guidelines are based on varying views of the issues they focus on and of the benefits or disadvantages they provide. Guidelines improve safe practice and consistency of care, and hence patients are more likely to receive correct treatment. However, they ought to be used with discretion and interpretation is required individually with each patient. The application of guidelines has been objected due to the fact that individual clinical decision-making on care and treatment options can be limited. (Craig & Smyth 2007: 259-260.)

Craig and Smyth (2007: 239) state that local guidelines have fewer resources but are more likely to be applied in clinical nursing practice, despite often not having adequate skills and resources in the development. Clinical guidelines are an excellent way to integrate evidence to clinical nursing practice (Craig & Smyth 2007: 261).

2.2 Peripheral intravenous antimicrobial medication administration

Intravenous administration passes medication and fluids to the blood circulation. This route conveys the medication directly to all tissues of the body with 100% bioavailability, compared to other routes that include the factor of absorption that affects the level of drug in bloodstream. This route is preferable when quick onset of action is required. (Adams & Urban 2013:37; Lavery & Ingram 2008:44.)

As nurses are responsible for delivering intravenous therapy, they need to comprehend the indications why their patients have vascular access devices and that they should be removed when no longer required. Intravenous cannulae are a direct route for microbial contamination in the bloodstream and a significant factor in causes of morbidity and mortality. Hence good nursing pracitice is vital in intravenous therapy and in infection control. (Scales 2008: 12.)

Despite its many advantages, intravenous administration is irreversible and medication is irretrievable once given (Aschenbrenner & Vennable 2009: 34). The intravenous route of administration carries a variety of risks such as local irritation, phlebitis, infiltration, extravasation, infection, fluid overload, embolism, thrombosis, anaphylaxis and even death (Scales 2008: 4; Intravenous Nursing New Zealand Incorporated Society 2012: 56-62). Medications ought to be administered according to prescription from a licenced practitioner. Aseptic technique as well as standard safety measures need to be observed whilst administering intravenous medications and solutions. (Dougherty et al. 2010: 45.)

The peripheral intravenous route of medication administration should only be chosen when other routes are not applicable, and when rapid response is required among others. Nurses are responsible for the safe and accurate administration of medicines, hence they need to understand the indications and contraindications for intravenous administration and the care and management of the peripheral access device. (Downie, Mackenzie, Williams & Hind 2010: 64; Scales 2008: 4.)

Three main forms of intravenous administration are large-volume infusion, intermittent infusion and bolus administration. In large-volume infusion the medication is mixed to a large volume of infusion fluid such as normal saline. Medications that need to be diluted or infused slowly can be administered intermittently with a flow control device or by gravity. A bolus injection of medication means administering a single dose of medication into the bloodstream without dilution or a background infusion. (Adams & Urban 2013: 37; Scales 2008: 8.)

There are three main types of intravenous access devices; peripheral venous catheters, midline catheters and central venous access devices (Taylor, Lillis, LeMone, & Lynn 2010: 1448). The veins of the ventral and dorsal upper extremities, for example the metacarpal, cephalic, basilic, and median veins, are to be considered for peripheral

intravenous access. Lateral and ventral surfaces of the wrists, compromised veins (bruised, infiltrated, phlebitic, sclerosed, or corded) and veins in the lower extremities should be avoided because of potential tissue and nerve damage, thrombophlebitis and ulceration, respectively. (Intravenous Nursing New Zealand Incorporated Society 2012: 32.)

Aseptic technique in intravenous medication administration includes hand-washing before and after clinical procedures and both before and after using gloves. Gloves do not protect the nurse from needlestick injury, instead they are worn for protective purposes against contamination by for example blood, bodily fluids, micro-organisms and also toxic substances. The nurse should wear a disposable apron for preventing the contamination of clothing. Face masks and caps are not necessary in infusion procedures, but are used in situations where there is a risk of splashing bodily fluids or some other hazardous substances into the nurse's face, mouth or eyes. Finally, the use of protective equipment prevents contamination among staff and patients. (Dougherty et al. 2010: 10-12.)

It is important for the nurse to decontaminate the tops of ampoules and vials, the additive ports of infusion bags and the catheter hubs by rubbing an antimicrobial solution with friction. The solution should be left to dry before access or use. This is done in order to prevent the entry of micro-organisms to blood circulation. (Dougherty et al. 2010: 12,22.)

Ideally, preparations that are in a form ready for administration should be used. If these are not available, they should be prepared in an appropriate location and all hazards should be minimized. Medications that are hazardous to the health must be reconstituted in a laminar flow cabinet, where air flow is led in a way that prevents contamination by airborne micro-organisms. Guidelines provided by the manufacturer must be followed for reconstitution of specific medications. The reconstitution and administration of medications must be ascertained according to their chemical, physical and therapeutic properties. In these circumstances a registered pharmacist should be consulted about the compatibilty of medications. (Dougherty et al. 2010: 11-12; Medical Dictionary for the Health Professions and Nursing 2012.)

The medication should be labeled immediately after preparation to ensure patient safety. The label should state the name, strength and volume of the medication and

diluent, the route of administration, the name of the receiving patient, expiry date and the name of the nurse who prepared the medication (Dougherty et al. 2010: 12).

Storage of medication should follow the guidelines provided by the manufacturer to ensure the validity of the expiry date. Health care professionals should verify the expiry date by checking the attached labels before initiating the medicine administration or using of equipment and products. Medication or solutions that have been added into an infusion bag should be disposed of or infused within 24 hours. (Dougherty et al. 2010: 12,45.)

Healthcare workers are at risk of being infected with HIV, hepatitis B, hepatitis C and other blood borne diseases due to accidental puncture with a needle infected with blood. Broken or bent sharps must not be resheathed but disposed of in impenetrable, puncture resistant and tamper proof containers. Containers for hazardous material and wastes should be used to dispose of the sharps accordingly. Sharps containers should be carried by their handles and placed in a secure place away from the public prior to ultimate disposal as medical waste by incineration or other high temperature system. (Dougherty et al. 2010: 13; Downie et al. 2010: 71.)

The nurse's responsibility is to ensure that medications and delivery systems are compatible. The preparation should be checked by another person before infusion. The vascular access device needs to be decontaminated with antimicrobial solution and flushed sufficiently between administering different medications. (Dougherty et al. 2010: 12, 22, 45.)

After the administration of intravenous antimicrobial medication the nurse should document in the patient's records the antimicrobial drug administered, including the dose, rate, time and the route of administration. The assessment and monitoring of the patient's symptoms and vital signs as well as their response to therapy, including adverse reactions and complications, should be documented accordingly. (Dougherty et al. 2010: 16-18.)

Administration sets need to be replaced immediately after suspected or actual contamination occurs, or the integrity of the system is compromised. Sets used for continuous infusion must be replaced after 72 hours of previous change, and those used for intermittent infusion every 24 hours. Aseptic technique and the manufacturer's instructions

ought to be followed when handling administration sets, add-on devices and electronic flow-control equipment. (Dougherty et al. 2010: 20, 23; Scales 2008: 10.)

Antimicrobial medication that is not suitable for the patient or is administered incorrectly can have undesired effects with dire consequences for the patient (Wanzer, Goeckner, & Hicks, 2011: 341). Therefore, the nurse needs to ensure safe and consistent, evidence-based practice by using for example the 9 rights of intravenous therapy: confirm the identity of the patient, the prescription and appropriateness of the drug, the suitability of the intravenous administration route, the correct dosage, dilution and infusion rate, the correct timing, the monitoring of the patient and the documentation. (Lavery 2011: 33-34.)

3 Purpose, aim and study question

The purpose of this final project is to describe the existing guidelines of peripheral intravenous antimicrobial medication administration, with the ultimate goal to improve the use of guidelines in nursing practice. The study question is as follows: what are the existing guidelines for administration of peripheral intravenous antimicrobial medication?

4 Method

4.1 Literature review

A literature review is an extensive research and analysis of literature about a specific subject. The aim of a literature review is to produce a summary of the existing literature, where relevant articles are searched and analysed to form a comprehensive description of the topic. Allowing single pieces of research to be seen within a wider context of related literature, these reviews are generally more useful to health care practitioners. Due to the increasing importance of evidence based practice in nursing, literature reviews have become more relevant to nursing practice. (Aveyard 2011: 2; 5-6; 22.)

A systematic review is the most accurate form of literature review. A detailed documentation of the study process is important to demonstrate the literature search, analysis and synthesis. (Aveyard 2011: 13-14; 19-20.) Undertaking a systematic approach in the review of literature is essential to ensure all relevant data available is collected to the review. Carrying out such a review includes following a focused searching strategy to "identify, critically appraise and synthetize relevant studies". This involves continuing the search until exhaustion, all in order to ensure no relevant literature remains omitted. (Aveyard 2011: 14.)

The reviewers establish criteria of inclusion and exclusion that are used to critique the identified literature. To ensure that only papers of high quality and relevance to the study question are selected for review, search results that fail to meet the inclusion criteria are excluded. (Aveyard 2011: 14.) In this final project the principles of literature review are applied.

4.2 Data collection and selection

According to Parahoo (2014:126) "every effort to locate all relevant studies must be made". Thus several initial article searches were carried out during autumn 2014 to identify relevant search terms and to explore relevant databases. These searches provided insight and knowledge for background information which helped the authors to initiate the development of relevant search terms and. The principles of a literature review were applied to identify guidelines for peripheral intravenous antimicrobial medication administration. The data collection consisted of searches in the PubMed, Medline, Cinahl and Cochrane online databases for publications between January 2004 and December 2014. The search terms "peripheral intravenous" "antimicrobial", "intravenous antimicrobial", "intravenous administration", "intravenous therapy", "infusion therapy", "IV", "guidelines" and "nurs*" were used.

Articles were selected from the search results in a systematic manner and the initial selection was based on the title. In total 1343 search results were identified. The inclusion criteria (Table 1) were applied to the title and thereafter 350 articles were chosen for further assessment. The authors applied the same criteria in the assessment of abstracts. However, potentially relevant articles without abstracts were chosen for full review. After selecting and reading 140 relevant articles entirely, 12 articles were chosen for content analysis. Of the 12 articles five were about the use of

antimicrobials in treatment of infection, three were about the prophylactic use of antimicrobials in surgery, one recommendation was for prophylaxis and treatment of HIV-1 infection in pregnancy and one was about antimicrobial use in donor care. Sources included five pharmaceutical, five medical and only two nursing journals. The data collection and selection is summarised in Table 2 (Appendix 1) and the chosen literature is presented in Table 3 (Appendix 2).

Table 1. Inclusion and exclusion criteria in database searches

Inclusion criteria	Exclusion criteria
Focus on peripheral intravenous administration and antimicrobial medication	Focus on central intravenous administration and other topics irrelevant to study question
Full text published in English	Full text not available
Published in a scientific journal or as an evidence-based guideline	Lack of relevant guidelines, recommendations or instructions
Published within January 2004 and 2014	published before 2004

4.3 Data analysis

Like all literature, also guidelines need to be reviewed in detail to assess their quality in terms of validity, reliability. Unclear or absent documentation of evidence base is a limitation in the reliability of literature, and should be discussed even if the content is valid to the review. (Aveyard 2011: 118.)

Content analysis is an objective and systematic method that can be used for analysing documents with the aim of producing a comprehensive and extensive description of concepts identified within the topic. It can be used to analyse both qualitative and quantitative data in a deductive or inductive manner. (Elo & Kyngäs 2008: 108-109.)

The principles of an inductive content analysis were applied as recommended by Lauri and Kyngäs (2005, cited in Elo & Kyngäs 2008: 109). In inductive content analysis words, phrases or themes derived from the data are systematically grouped into categories, allowing particular items to be analysed and combined into general statements. The reason of forming categories is to organize knowledge to enhance understanding of the topic. (Elo & Kyngäs 2008: 108-111.)

According to Elo and Kyngäs (2008: 111) abstraction can be defined as a means of formulating a comprehensive description of the study topic by generating categories.

These categories are named with words that characterize their content. Subcategories with similar content are joined together into categories, which are further grouped into main categories. The purpose is to continue this to a reasonable extent.

The authors analyzed the chosen articles together. Parts of text, such as short sentences, tables or entire chapters that were relevant to the study question were highlighted. The highlighted quotations were further analyzed and the authors identified guidelines, recommendations or instructions concerning several elements of peripheral intravenous antimicrobial administration. The highlighted sections in the articles were coded according to the identified elements. Similar elements were combined and eventually five distinct elements of the peripheral intravenous administration process were established. These were further grouped into two categories. The content analysis is summarized in table 4 (Appendix 3).

5 Findings

During the content analysis, guidelines, recommendations or instructions answering the study question were identified. In different articles there was inconsistency in where the guidelines were located because the structure of the articles differed in various sources. Five key elements of intravenous administration of antimicrobials emerged. Different guidelines, recommendations and instructions regarding the dosage, preparation and storage of intravenous solutions as well as the duration and timing of infusion of antimicrobial medication were found. These were further grouped into the categories named preparation and infusion of intravenous antimicrobial medications.

5.1 Preparation of intravenous antimicrobial solution

The authors identified guidelines for preparation of antimicrobial drugs. These instructed in the dosing, reconstitution and storage of intravenous antimicrobial solutions.

5.1.1 Dosage of antimicrobial medication

All articles chosen for review had guidelines or recommendations regarding dosage. Seven articles, all of which were pharmaceutical reviews, discussed specific antimicro-

bial agents (Anderson & Perry 2008; Frampton 2013; Hylands 2008; Kasbekar 2006; Keady & Thacker 2005; Mariat et al. 2006; Schriever et al. 2005). Dosage adjustment for patients with hepatic impairment, such as no need for adjustment or need for reduced drug dosage, was discussed in four guidelines (Frampton 2013: 1084; Hylands 2008: 262; Kasbekar 2006: 1241; Schriever et al. 2005: 1154). Six articles recommended no adjustments or drug dosage reductions according to creatinine clearance values for patients with renal impairment or undergoing dialysis (Anderson & Perry 2008: 557; Frampton 2013:1084; Hylands 2008: 262; Kasbekar 2006:1241; Powner & Allison 2007: 272; Schriever et al. 2005: 1154). One guideline gave specific dosages of antimicrobials in pediatric patients (Bratzler et al. 2013: 197) and one provided dosage information for delivering mothers and their infants (Navér et al. 2011: 415).

5.1.2 Reconstitution of solution

Two articles (Hylands 2008:261; Schriever et al. 2005: 1154) had guidelines for the reconstitution of intravenous solutions. Both articles instructed the choice of diluent to use in reconstitution of the intravenous antimicrobial solution. Hylands (2008: 261) also described the reconstitution process in more detail, including the volume of diluent to use.

5.1.3 Storage of intravenous antimicrobial solutions

One article (Schriever et al. 2005:1154) had a guideline about storage. The guideline stated how long the intravenous solution will be stable in both room temperature and refrigerated.

5.2 Intravenous infusion of antimicrobial medication

The guidelines for infusion instructed or recommended the timing, or administration interval, and duration of intravenous antimicrobial medications either related to general use or to specific treatments and prophylaxis.

5.2.1 Timing of infusion

All the 12 articles chosen for review had guidelines about the timing of antimicrobial infusion. Five guidelines had specific timing recommendations regarding prolonged administration intervals according to creatinine clearance values for patients with renal impairment (Anderson & Perry 2008: 557; Frampton 2013: 1084; Kasbekar 2006: 1241; Powner & Allison 2007: 272; Schriever et al. 2005: 1154). Navér et al. (2011: 415) recommended timing of infusion for women during delivery and for the infant.

Three guidelines regarding patients undergoing dialysis had specific timing instructions for intravenous antimicrobial medications. Two of them recommended prolonged intervals of dosing (Anderson & Perry 2008:557; Schriever et al 2005: 1154). The latter guideline instructed to infuse antimicrobials after haemodialysis. A third study discussed patients receiving continuous infusion of antimicrobial medication while undergoing continuous venovenous hemodiafiltration (Mariat et al. 2006).

5.2.2 Duration of infusion

Nine articles (Anderson & Perry 2008: 557; Frampton 2013: 1084; Hylands 2008: 261; Kasbekar 2006: 1241; Keady & Thacker 2005: 371; Mariat et al. 2006: 1; Navér et al. 2011: 415; Schriever 2005: 1154; Wolf et al. 2008: 1384) had recommendations regarding the duration of infusion of which three had recommendations of infusion rate (Keady & Thacker 2005; Mariat et al. 2006; Navér et al. 2011). Mariat et al. (2006) recommend an infusion rate for a continuous infusion and Navér et al. (2011) recommended the duration of infusion for women during delivery and for the new born infant.

6 Discussion

The purpose of this final project was to describe the guidelines for peripheral intravenous administration of antimicrobial medication. A review of literature obtained from the Medline, CINAHL, Cochrane and PubMed databases was carried out, and only scarce and fragmented guidelines relevant to nursing practice were identified. Only two relevant articles from a nursing publication were chosen, the remaining ten being from medical and pharmaceutical literature.

In this literature review no comprehensive guidelines relevant to nursing practice in the administration of intravenous antimicrobial medication were identified. Out of 1343 search results yielded from four databases, only 12 were considered relevant to the study question. The identified guidelines instructed what to do in specific situations, but no description of how the intervention ought to be carried out could be found. In the absence of evidence-based, comprehensive guidelines of how to perform nursing interventions, nursing practice is based on tradition which may cause errors or inconsistency in the adminstration of intravenous medication to occur. Patient safety will be compromised in these situations.

Majority of the excluded articles were discarded due to lack of clear guidelines or recommendations. Several review articles merely stated their results, such as one antimicrobial agent being superior to another, but no recommendations or instructions could be identified within the article. In addition, most excluded articles did not provide guidelines or they did not even discuss the administration process of intravenous antimicrobial medications, but rather focused on pharmacological properties or medical outcomes.

During the last phase of the article selection process the authors deemed articles titled as research protocols to be consistently unfit for the review, because they focused on describing a research plan without providing recommendations nor guidelines. Lastly, many articles did not initially specify the route of administration to be intravenous, instead the route of administration was described only in sections other than the title or the abstract. Due to this factor, articles that were initially deemed relevant, were discarded only in the final selection stage when the full articles were assessed.

Guidelines for clinical nursing interventions like intravenous medication administration need to guide how to perform the intervention. No single guideline instructed how the comprehensive process of intravenous antimicrobial medication administration should be carried out, and therefore they cannot be used as guidelines in the clinical nursing procedures of preparation and infusion of medication. While the findings contained information relevant to nursing, they cannot be used in clinical practice.

7 Ethics and validity

The authors strived to carry out this final project according to ethical principles which are endorsed by the research community in Finland (Finnish Advisory Board on Research Integrity 2012). To ensure validity of a literature review the authors need to appraise several aspects. To our best knowledge, the aim of the final project is clearly defined, the background literature is connected to the data reviewed, and the chosen research method is relevant to the research question.

The study method used in this literature review are accurate. Ethically sustainable methods that comply with scientific criteria have been used to perform the data search, selection, analysis and reporting the study findings. Both authors read all articles chosen for the review and each phase of the analysis process was carried out together. The findings were presented as accurately as possible without adding any subjective content. The work of other researchers has been taken into consideration, credited and cited accordingly. This means no findings were fabricated, plagiarised or falsified during this final project.

The documentation of the data collection and analysis should be clear and transparent to the reader and the findings objectively presented. (Maltby, Williams, McGarry & Day 2010: 252-258). The authors have strived to achieve this by using methodological literature (Aveyard 2011, Parahoo 2014, Elo & Kyngäs 2008 and Finnish Advisory Board on Research Integrity 2012) as reference throughout the final project to ensure the validity of the study. In any problematic situations the aforementioned professional literature was utilised to solve methodological issues and thus the authors have to their best knowledge applied the principles of literature review and inductive content analysis in a correct and accurate manner. In addition, guidance from the highly qualified senior lecturer instructors has been utilised regularly throughout the final project.

No ethical issues arose during this literature review, and any disagreements were resolved through discussion. However, possible limitations to the validity of this study include the authors' lack of experience in reviewing and critically appraising professional literature. Moreover, the data was collected from only academic publications in a limited time frame, thus many guidelines that are used in clinical practice might have been omitted if they have not been published in academic journals, or if they have not been published within the ten-year time frame applied for this review.

8 Conclusion

During this final project, the authors found that there is an abundant variety of high quality, evidence based medical guidelines. The scarcity and poor quality of nursing guidelines was evident. This finding emphasizes the crucial need for clinical nursing perspective in future guideline development. Nurses are competent professionals who should be encouraged to find, understand and, most importantly, document the clinical evidence behind their practices, even the ones based on good traditions. Documenting best practices should be encouraged and supported by both management and practicing nurses.

Nurses need to actively get their voices heard and take part in producing policies, recommendations and clinical guidelines on local and national levels. When the viewpoints of all members of the multiprofessional health care team are included, they will be able to provide the highest quality, evidence-based care to their patients. Inconsistency, errors and adverse events can be reduced when all health care professionals adhere to the same guidelines, which will also promote teamwork in health care and be beneficial to patients.

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Table 2. Data collection and selection

Database	Search terms	Limitations	Hits	Chosen by title	Chosen by abstract	Chosen by full text
CINAHL	Peripheral intravenous AND antimicrobial medications AND best practices	2004-2014 English	99	10	5	2
	Antimicrobial AND intravenous administration AND guidelines	2004-2014 English	3	2	1	1
	Antimicrobial AND intravenous administration AND guidelines AND nurs*	2004-2014 English	0	0	0	0
	Intravenous Antimicrobial AND intravenous administration AND nurs*	2004-2014 English	1	0	0	0
	Intravenous Antimicrobial AND best practice AND nurs*	2004-2014 English	153	30	8	4
	Intravenous antimicrobial AND recommended guidelines AND nurs*	2004-2014 English	131	41	15	5
Medline	Peripheral intravenous AND antimicrobial medications AND best practices	2004-2014 English 5 star relevance	0	0	0	0
	Antimicrobial AND intravenous administration AND guidelines	2004-2014 English 5 star relevance	2	0	0	0
	Antimicrobial AND intravenous administration AND guidelines AND nurs*	2004-2014 English 5 star relevance	0	0	0	0
	Intravenous Antimicrobial AND intravenous administration AND nurs*	2004-2014 English 5 star relevance	0	0	0	0
	Intravenous Antimicrobial AND best practice AND nurs*	2004-2014 English 5 star relevance	0	0	0	0
	Intravenous antimicrobial AND recommended guidelines AND nurs*	2004-2014 English 5 star relevance	0	0	0	0

Cochrane	Peripheral intravenous AND antimicrobial medications AND best practices	2004-2014 English	32	12	4	0
	Antimicrobial AND intravenous administration AND guidelines	2004-2014 English	118	59	23	0
	Antimicrobial AND intravenous administration AND guidelines AND nurs*	2004-2014 English	52	18	11	0
	Intravenous Antimicrobial AND intravenous administration AND nurs*	2004-2014 English	68	25	15	0
	Intravenous Antimicrobial AND best practice AND nurs*	2004-2014 English	67	23	13	0
	Intravenous antimicrobial AND recommended guidelines AND nurs*	2004-2014 English	49	18	11	0
PubMed	Peripheral intravenous AND antimicrobial medications AND best practices	2004-2014 English	0	0	0	0
	Antimicrobial AND intravenous administration AND guidelines	2004-2014 English	292	82	24	2
	Antimicrobial AND intravenous administration AND guidelines AND nurs*	2004-2014 English	15	2	1	0
	Intravenous Antimicrobial AND intravenous administration AND nurs*	2004-2014 English	123	27	9	2
	Intravenous antimicrobial AND best practice AND nurs*	2004-2014 English	15	2	0	0
	Intravenous antimicrobial AND recommended guidelines AND nurs*	2004-2014 English	6	0	0	0
Total			**1343**	**350**	**140**	**12**

Table 3. Analysed articles (n=12)

Author(s), year, country where the study was conducted	Purpose	Participants (sample size)	Data collection and analysis	Main results	Remarks
Anderson, V. & Perry, C.: Levofloxacin: A Review of its Use as a High-Dose, Short-Course Treatment for Bacterial Infection, 2008, USA	To examine the pharmacology of levofloxacin and focus specifically on the clinical profile of the high-dose, short-course regimen in the treatment of adults with community-acquired pneumonia, acute bacterial sinusitis, complicated urinary tract infection and acute pyelonephritis	Not clearly stated	Database search (MEDLINE, EMBASE), manual search. Analysis not discussed.	Levofloxacin is a valuable antimicrobial agent that has activity against a wide range of bacterial pathogens; however, it's use should be considered carefully so that the potential for resistance selection can be minimized and it's usefulness in severe infections and against a range of penicillin- and macrolide resistant pathogens can be maintained.	Instructions in a pharmaceutical review
Bratzler et al.: Clinical practice guidelines for antimicrobial prophylaxis in surgery, 2013, USA	An update to a previously published American Society of Health System Pharmacists Therapeutic Guidelines on Antimicrobial Prophylaxis in Surgery (1999), as well as guidelines from Infectious Disease Society of America and Surgical Infection Society.	Not clearly stated	Not clearly stated	Key updates on pre-operative dose timing, selection and dosing, duration of prophylaxis and common principles.	Clinical practice guidelines

Frampton, J.: Ceftaroline Fosamil: A Review of its Use in the Treatment of Complicated Skin and Soft Tissue Infections and Community-acquired Pneumonia, 2013, Switzerland	To review antibacterial activity, pharmacodynamic and pharmacokinetic properties, efficacy and tolerability of ceftaroline fosamil.	Not clearly stated	Database search (MEDLINE; EMBASE), manual search. Analysis not discussed.	Ceftaroline, the active metabolite of ceftaroline fosamil is an advanced-generation, parenteral cephalosporin with a broad spectrum of microbiological coverage that includes pathogens commonly implicated in skin and soft tissue infections and community acquired pneumonia.	Recommendations in a pharmaceutical review
Hylands, J: Tigecycline: A new antibiotic, 2008, UK	To review the clinical efficacy, side effect profile, dosing and administration of tigecycline and discusses the warnings and precautions associated with the use of the drug.	Not stated	Not stated	Tigecycline may be used for complicated intra-abdominal and complicated skin and soft tissue infections. It is also likely to find a role in the treatment of infections caused by multi-resistant organisms.	Instructions in a pharmaceutical review in a nursing journal
Kasbekar, N: Tigecycline: A new glycylcycline antimicrobial agent, 2006, USA	To review the pharmacology, spectrum of activity, pharmacokinetics, clinical efficacy, adverse events, dosage and administration, drug interactions and place in therapy of tigecycline.	Not stated	Not stated	Tigecycline is a valuable treatment option for management of multi-drug resistant organisms when first line therapy fails. It provides a new option for penicillin-allergic patients or patients with intolerance to other antimicrobial agents.	Recommendations in a pharmaceutical review

Keady, S. & Thacker, M.: Voriconazole in the treatment of invasive fungal infections, 2005, UK	To review the clinical efficacy, side effect profile, dosing and administration schedule of voriconazole.	Not stated	Not stated	Voriconazole is an effective treatment option in the management of fungal infections.	Recommendations in a pharmaceutical review in a nursing journal
Mariat, C. et al.: Continuous infusion of ceftazidime in critically ill patients undergoing continuous venovenous hemodiafiltration: pharmacokinetic evaluation and dose recommendation, 2005	To analyze the pharmacokinetics of ceftazidime administered by continuous infusion in critically ill patient during continuous venovenous hemodiafiltration in order to identify the optimal dose in this setting.	7 patients	Blood samples were collected simultaneously for pharmacokinetic and statistical analysis	A dosing regimen of 3g/day ceftazidime by continuous infusion, following a 2 g loading dose, results in serum concentration more than 4 times the minimum inhibitory concentration for all susceptible pathogens.	Recommendations in a medical article
Navér et al.: Prophylaxis and treatment of HIV-1 infection in pregnancy: Swedish Recommendations 2010, 2011, Sweden	Availability of new antiretroviral drugs, updated general treatment guidelines and increasing knowledge of the importance of drug resistance have necessitated updating the previous (2007) recommendations.	Not stated	Not clearly stated	Several updates in different recommendations	Prophylaxis and treatment recommendations
Powner, David J. & Allison, Teresa A.: Bacterial infection during adult donor care, 2007, USA	To review issues of bacterial infection in adult organ donor care.			Appropriate treatment of documented or suspected bacterial infections in the donor may be important to the recipient. Therefore, the organ procurement co-	Recommendations in a medical article

				ordinator is challenged to continue hospital-based efforts to prevent infection, to diligently review all prior culture data, and to search for clinical and laboratory signs of new infection.	
Schriever, C. et al.: Daptomycin: A novel cyclic lipopeptide anti-microbial, 2005, USA	To review the development, activity, pharmacokinetics, pharmacodynamics, clinical efficacy, adverse effects, dosage and administration of daptomycin.	Not stated	Not stated	Daptomycin is bactericidal against a range of gram-positive bacteria, including many multiple-drug-resistant isolates. It has only minimal activity against anaerobic bacteria and no activity against gram-negative bacteria. Daptomycin offers an option in the treatment of complicate skin and skin structure infections.	Instructions in a pharmaceutical review
Trampuz, Andrej; Zimmerli, Werner: Antimicrobial agents in orthopedic surgery, 2006, Switzerland	To review the pathogenesis, prophylaxis and treatment of orthopaedic device-associated infections.	Not stated	Not stated	Perioperative prophylaxis should be administered between 60 and 30 minutes before incision. The duration of prophylaxis should not exceed 1 day.	Recommendations in a medical review article
Wolf, J. et al.: Best Practice Policy Statement on Urologic Surgery	To formulate recommendation on the use of antimicrobial	Not stated	Database search (MEDLINE), expert opinion, analysis	Antimicrobial prophylaxis is recommender only when the potential bene-	Best practice policy statement

Antimicrobial Prophylaxis, 2008, USA	prophylaxis during urologic surgery.		not discussed.	fit outweighs the risks and anticipated costs. Prophylaxis should begin within 60 minutes of surgical incision and generally should be discontinued within 24 hours.	

Table 4. Data Analysis

Source	Anderson & Perry 2008	Bratzler et al. 2013	Frampton 2013
Dosage	IV Levofloxacin Renal impairment Peritoneal dialysis	Commonly used antimicrobials in adults Commonly used antimicrobials in pediatrics	Ceftaroline fosamil in adults Moderate and severe renal impairment Hepatic impairment
Preparation			
Storage			
Timing of infusion	IV Levofloxacin Renal impairment Peritoneal dialysis	Commonly used antimicrobials in adults	Ceftaroline fosamil in adults Moderate and severe renal impairment
Duration of infusion	IV Levofloxacin		Ceftaroline fosamil in adults

Source	Hylands 2008	Kasbekar 2006	Keady & Thacker 2005
Dosage	IV tigecycline in general severe hepatic impairment	IV Tigecycline in general Tigecycline in renal impairment Hepatic impairment: mild and severe	IV Voriconazole for all patients
Preparation	Reconstitution with NaCl 0.9 % or dex-trose 5%		
Storage			
Timing of infusion	IV tigecycline in general	IV Tigecycline in general Tigecycline in renal impairment	IV Voriconazole for all patients
Duration of infusion	IV tigecycline in general	IV Tigecycline in general	IV Voriconazole for all patients

Source	Mariat et al. 2005	Navér et al. 2011	Powner & Allison 2007
Dosage	IV ceftazidime	For the woman in vaginal delivery at < 34 weeks For the infant born at > 34 weeks if oral not possible For infant < 34 weeks	Recommendations for empiric intravenous antibiotics for different conditions Recommendations for intravenous antibiotic dosing during renal failure
Preparation			
Storage			
Timing of infusion	IV ceftazidime continuous infusion	For the woman in vaginal delivery at < 34 weeks For the woman in cesarean delivery For the infant born at > 34 weeks if oral not possible For infant < 34 weeks	Recommendations for empiric intravenous antibiotics for different conditions Recommendations for intravenous antibiotic dosing during renal failure
Duration of infusion	IV ceftazidime continuous infusion	For the woman in vaginal delivery at < 34 weeks For the woman in cesarean delivery For the infant born at > 34 weeks if oral not possible For infant < 34 weeks	

Source	Schriever et al. 2005	Trampuz & Zimmerli 2006	Wolf et al. 2008
Dosage	IV daptomycin in general Renal dysfunction Hepatic dysfunction	For arthroplasty and internal fixation of closed fractures in centres with low infection rates Grade I and II open fractures in centres with unknown or high infection rates Internal fixation of grade III open fractures	Different antimicrobial agents for peripro-cedure use Antimicrobial prophylaxis for orthopedic patients
Preparation	Reconstitution with NaCl 0.9%		
Storage	Refrigeration up to 48 h Room temperature up to 12 h		
Timing of infusion	IV daptomycin in general Renal dysfunction After hemodialysis	Timing for perioperative prophylaxis before incision Timing when tourniquet is used For arthroplasty and internal fixation of closed fractures in centres with low infection rates Grade I and II open fractures in centres with unknown or high infection rates Internal fixation of grade III open fractures	Different antimicrobial agents for peripro-cedure use Antimicrobial prophylaxis for orthopedic patients
Duration of infusion	IV daptomycin in general	For arthroplasty and internal fixation of closed fractures in centres with low infection rates Grade I and II open fractures in centres with unknown or high infection rates Internal fixation of grade III open fractures	Antimicrobial prophylaxis for orthopedic patients